



# Stream Assessment using *INSTAR*

Greg Garman  
Leonard Smock  
Stephen McIninch  
William Shuart

**Virginia Commonwealth  
University**

**Programmatic Goal:** Protect and restore river and stream systems, including assemblages of stream-dependent, living resources, and the ecological services these systems provide.



**Programmatic Goal:** Protect and restore river and stream systems, including assemblages of stream-dependent, living resources, and the ecological services these systems provide.



**Assessment and Monitoring as a  
Critical Component of Effective Decision  
Support...a *Data-Dependent* Activity**



# What are the *data-related* challenges associated with stream monitoring and assessment programs?

- 1.) Lack of sufficient (useful) biological information on streams and rivers; data comparability & accessibility issues
- 2.) Need tools to support integration & analysis across multiple spatial and temporal scales (e.g. databases, GIS)
- 3.) Stream assessment methods require knowledge of appropriate, regional reference or target conditions
- 4.) Untested assumptions limit confidence in judgments
  - geomorphology *versus* biology
  - blue *versus* green infrastructure



# Project Background & Goals

- Pilot Stream Assessment Study (2000-2001)  
Goal: incorporate stream living resources data into NPS Assessment
- Statewide Watershed Prioritization) – 2002 NPS Assessment using pilot **mIBI** protocol
- Coastal Zone Stream Assessment (2003)
  - 1.) Expand Stream Database for CZ
  - 2.) Enhance NPS prioritization assessment (**mIBI**)
  - 3.) Create 'Virtual Stream' models for the CZ
  - \* 4.) Build **INSTAR** application for the CZ:  
Interactive Stream Assessment Resource



# INSTAR Program Goals

- Develop a comprehensive stream and river database and use it to conduct interactive and objective, geospatial assessments of lotic ecosystem health and function
- A novel decision-support tool that leverages an extensive, new biological database with GIS technology
- Focus on the Coastal Zone initially but also support statewide assessments



# Expand Stream Database for the Virginia Coastal Zone (Phase II)

- 4 major drainages (Potomac, Rappahannock, York, James) and 71 HUCs representing the Virginia Coastal Zone
- Over 400 stream reaches represented and >100K records incorporating fishes, macroinvertebrates, fw mussels, instream habitat, and geomorphology data; probabilistic sampling
- Extensive fieldwork during 2003-04 by VCU personnel, with assistance from VA DCR and VDGIF staff

**Largest, most comprehensive stream database in Virginia**



# Candidate Input Variables for Virtual Stream Models

## Biological

18 IBI metrics  
12 RBP III metrics  
others

## Geomorphology

4 Rosgen-type  
classification metrics

## In-stream Habitat

20 RHA metrics

## Landscape/Physiography

Stream order and link metrics  
(Green infrastructure)

Modeling exercise to answer: Which of these ~63 stream attributes are most closely related to stream integrity, structure, and function?



# Virtual Stream Models

Data QA/QC

Graphically assess data for outliers  
Make necessary transformations

Data Ordination; DCCA

Fish Data

Macroinvertebrate Data

Habitat Data

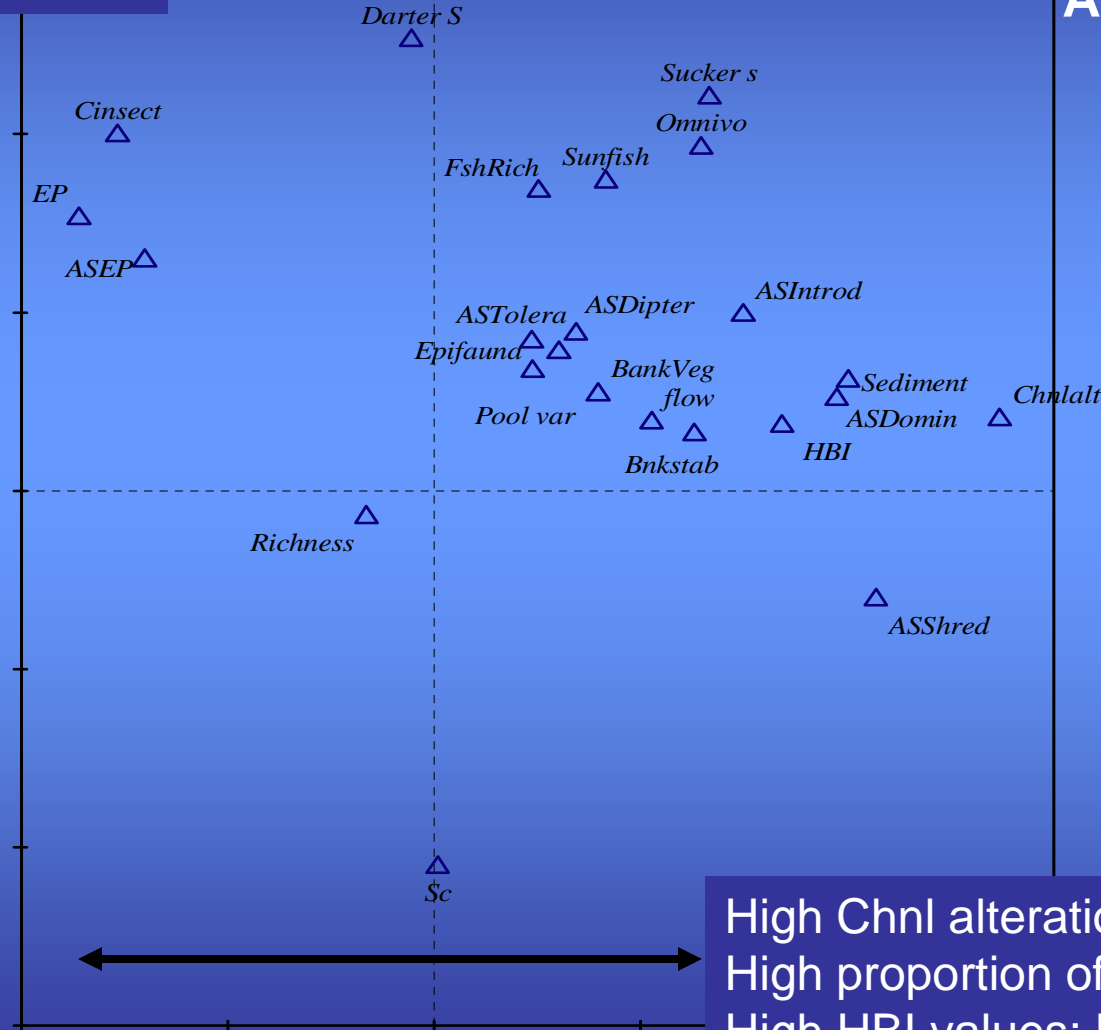
Combined Data Set

Model Creation via SMR



High # intolerant taxa  
High # darter species &  
insectivorous fishes  
Low # scrapers

## Detrended Canonical Correspondence Analysis (DCCA)



High Chnl alteration & sedimentation  
High proportion of dominant spp.  
High HBI values; low #EP taxa

# Virtual Stream Model—Lower Coastal Plain

$$\text{Virtual Reference Stream (100\%)} = 0.05(EP) + 0.02(Rich) - 0.19(Chnlalt) - 0.1(Intol) + 0.18(Toler) - 0.05(HBI) + 5.67$$

*EP* = Ephemeroptera & Plecoptera taxa

*Rich* = fish species richness (native)

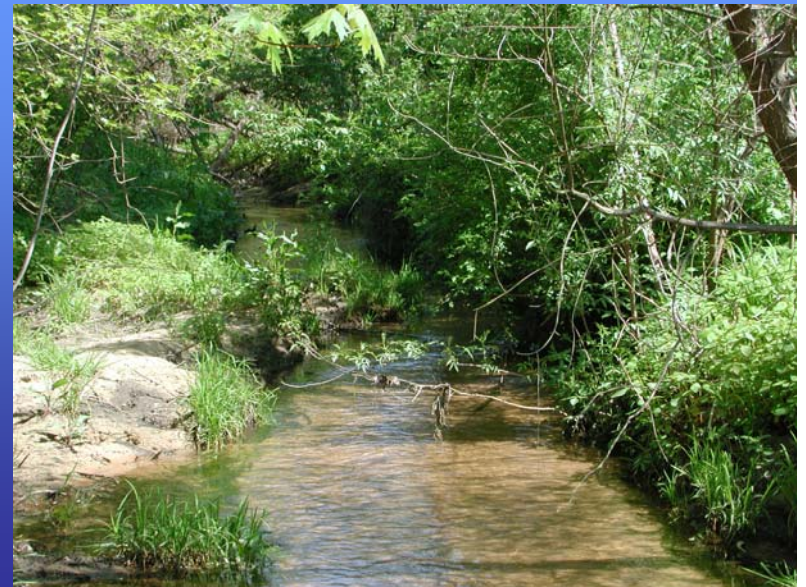
*Chnlalt* = percent channel alteration

*Intol* = percent intolerant species

*Toler* = number tolerant species

*HBI* = Hilsenhoff Biotic Index

**adjusted R square = 0.72**



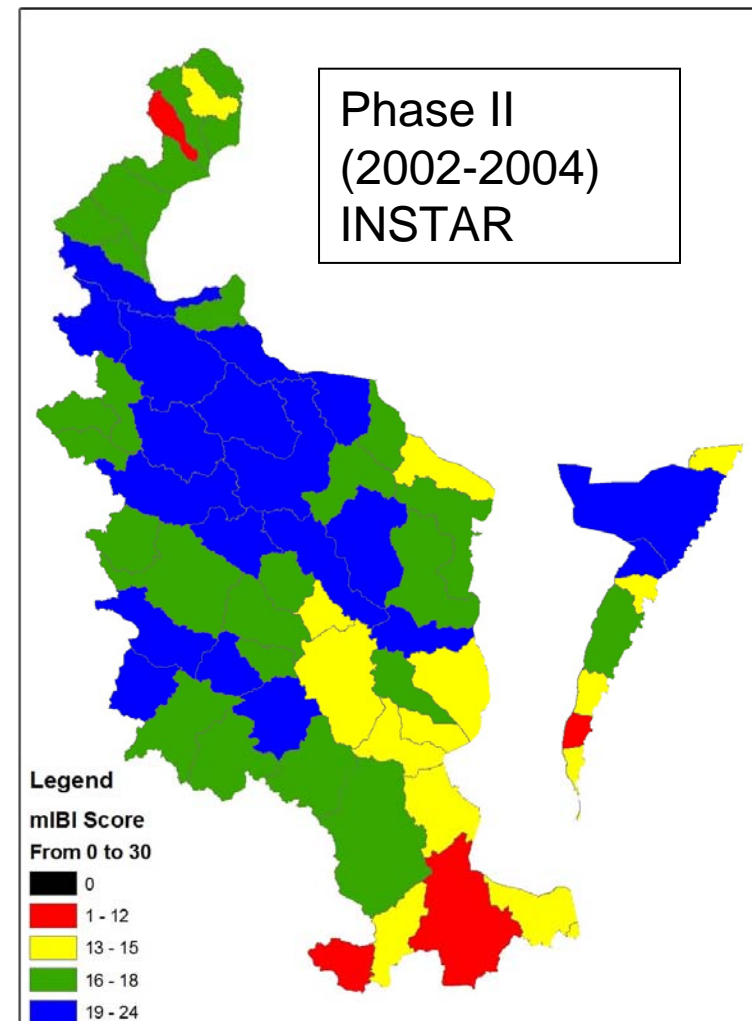
# INSTAR Interactive STream Assessment Resource

- Built on ESRI's **ArcIMS** application (internet mapping) and supported by three new, dedicated servers at VCU
- Wide range of functions:
  - Mapping utilities
  - Interactive and dynamic internet application
  - Database queries
  - \*Stream assessment protocols
    - Modified Index of Biotic Integrity (mIBI)
    - Virtual Stream Assessment (VSA)



# Modified Index of Biotic Integrity (mIBI)

- 1.) Taxonomic richness
- 2.) Native species richness
- 3.) Number of rare, threatened, and endangered species
- 4.) Number of non-indigenous species
- 5.) Number of critical species
- 6.) Number of tolerant species



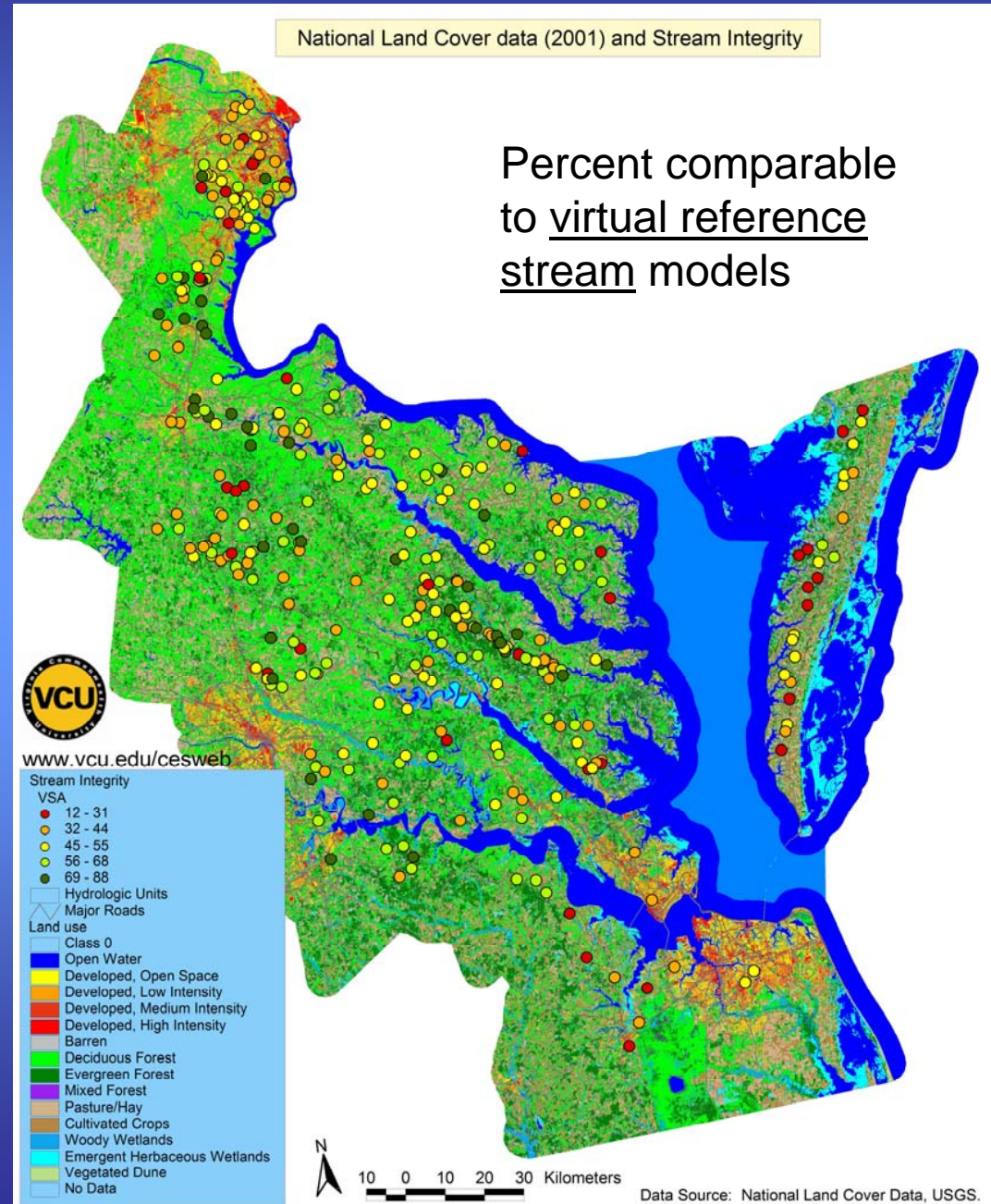
## Virtual Stream Assessment (Phase II)

432 Sites sampled in 65  
Coastal HUC's  
(probabilistic sampling)

Percent comparability to  
virtual reference conditions

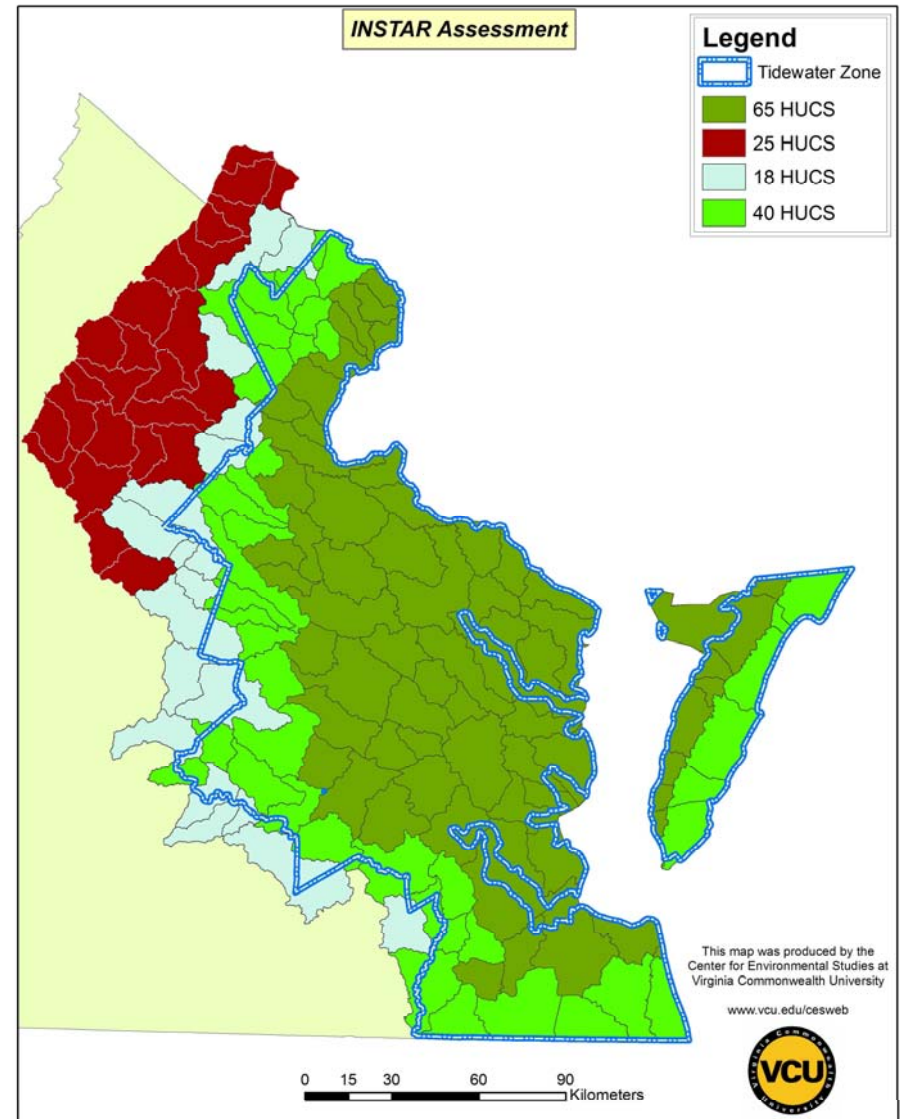
> 50% comparable (n=151)

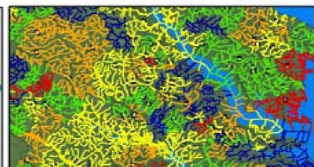
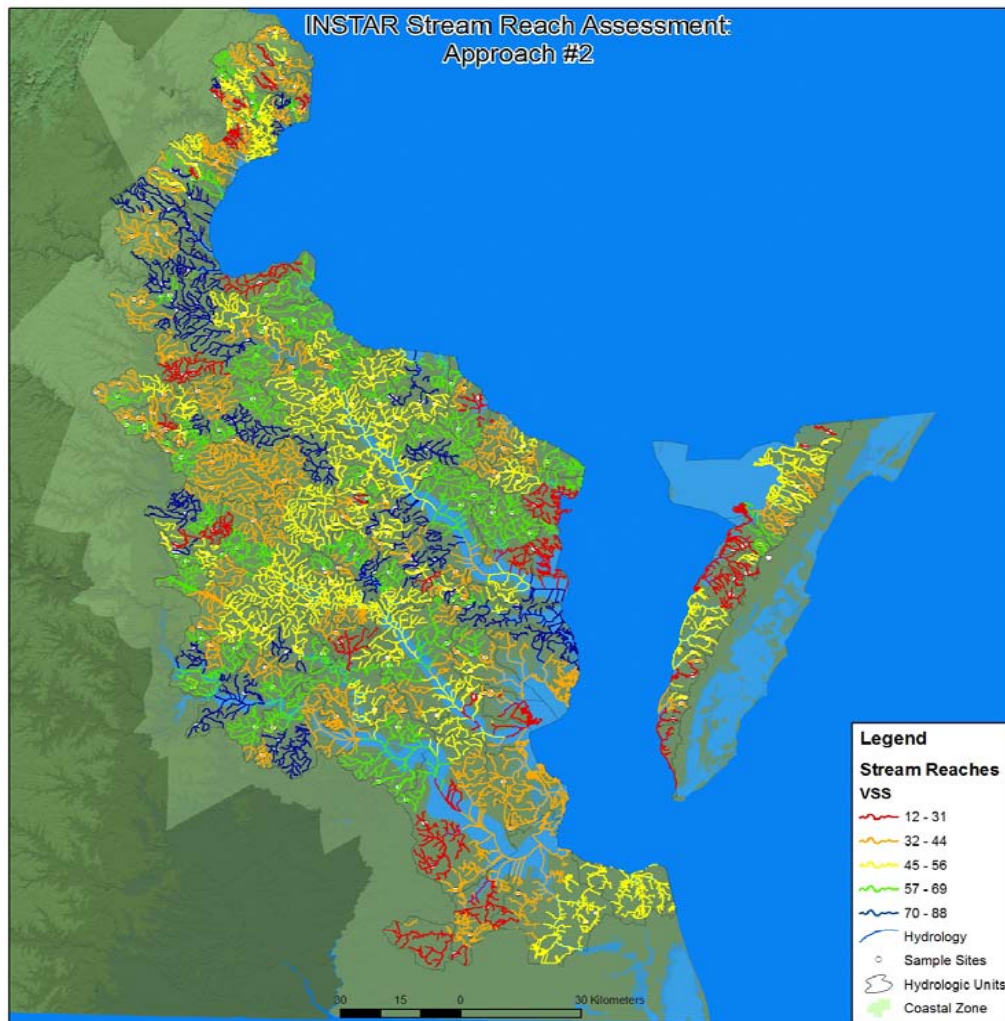
> 80% comparable (n=8)



# INSTAR *Phase III* (2004-2006)

- Expand database to include approximately 60 new HUCs in the Potomac, Rappahannock, York, and Chowan basins (30% of the state; >800 sites)
- Incorporate additional data and GIS layers (DEQ, USGS, ICPRB)
- Develop ‘designer’ versions of INSTAR (local gov’t; SOS)
- *Reach-level assessment*





This map was produced  
by the Center for Environmental  
Studies at Virginia Commonwealth  
University.  
[www.vcu.edu/cesweb](http://www.vcu.edu/cesweb)  
This map is not intended for  
navigational or regulatory purposes.

# Stream *Reach* Assessment using INSTAR



# INSTAR Applications

DEQ (Virginia Coastal Program)

Blue Infrastructure Assessment

DCR (Soil and Water Division)

NPS Statewide Prioritization

DCR (Natural Heritage Division)

Virginia Conservation Lands Needs  
Assessment

DOF (Virginia Stream Alliance)

Stream Restoration Assessment

DEQ (Water) 2006 305(b) report



# Utility of INSTAR ?

## Water Assessment and Monitoring

Statewide assessment tool

- interactive & integrative
- GIS analysis, maps and reports
- augment VSCI with VSA & mIBI
- supplement CEDS
- controlled user access
- regional reference conditions

Trend and change detection

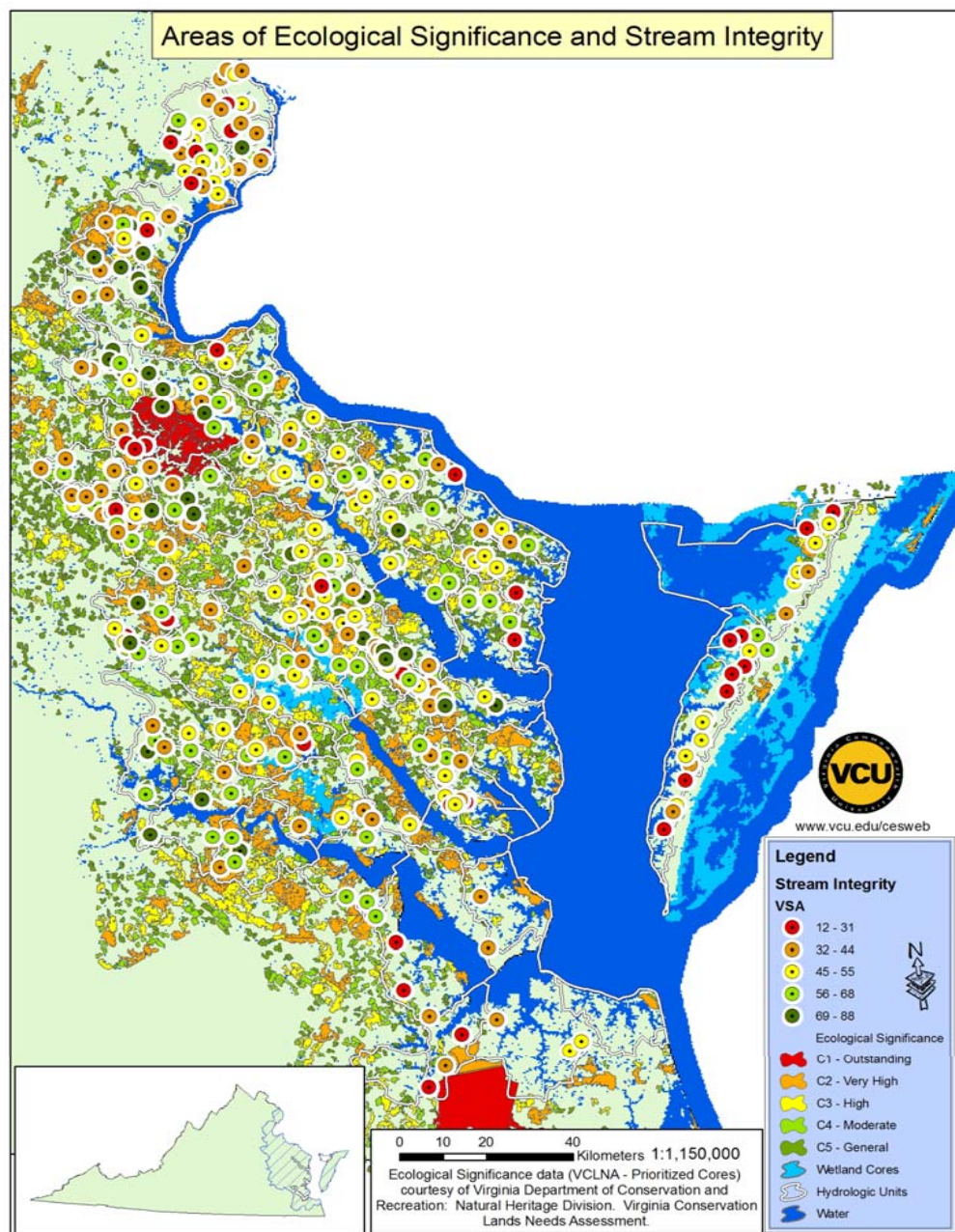
TMDL prioritization

305(b) & 303(d) Reports -- 2006



# Blue-Green Infrastructure Integration

## Virginia Conservation Lands Needs Assessment (VNH)

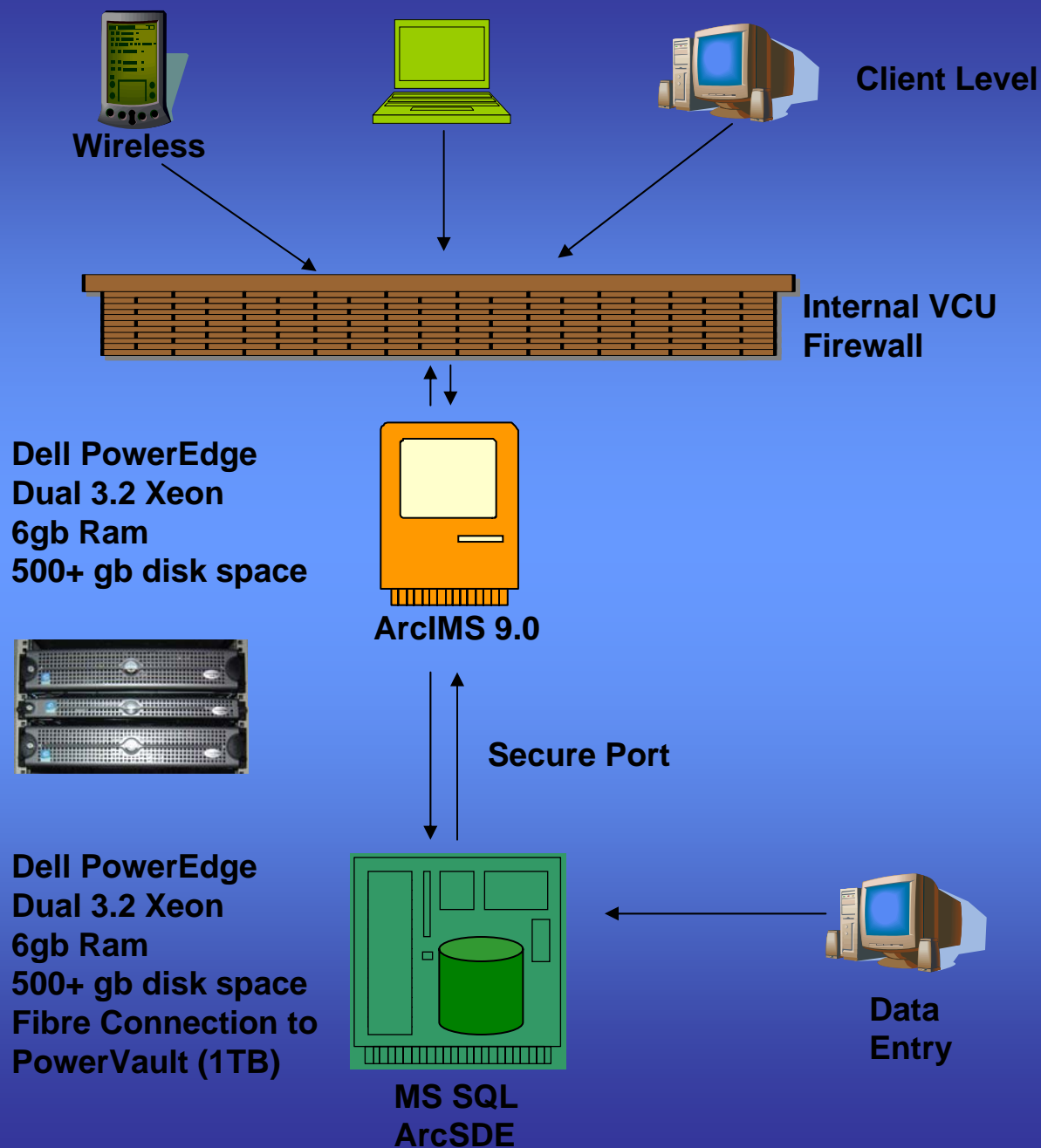


# Features of *INSTAR* version 2.0

- Encapsulated information
- User-friendly interface
- Dynamically updated legend
- Expanded database
- Reports (PDF) 'on-the-fly'
- Base maps:
  - High Resolution Aerial Imagery (USDA)
  - National Geographic TOPO!
- GIS and mapping tools
- FAST!!!



# INSTAR



# Acknowledgements

DCR Division of Soil and Water (Rick Hill, Beth Walls, Moira Croghan, Mark Slauter)

DEQ Coastal Program (Laura McKay, Julie Bixby)

DEQ Water Program (Darryl Glover, Roger Stewart)

VCU (Viverette, Hopler, Wright, Garey, and Nelson)

DCR Natural Heritage (Steve Carter-Lovejoy, Joe Weber)

Virginia Stream Alliance (Mike Foreman)

VDGIF Wildlife Diversity (Shelly Miller)

For more information contact:

Greg Garman ([ggarman@mail2.vcu.edu](mailto:ggarman@mail2.vcu.edu))

Len Smock ([lsmock@mail1.vcu.edu](mailto:lsmock@mail1.vcu.edu))

